[4910-13] August 31, 1995

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

[14 CFR part 25]

[Docket No. xxxxx; Notice No.]

RIN:

Revision of Hydraulic Systems Airworthiness Standards to Harmonize with European Airworthiness Standards for Transport Category Airplanes.

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of proposed rulemaking.

SUMMARY: This notice proposes to amend the airworthiness standards for transport category airplanes to harmonize hydraulic systems design and test requirements with standards proposed for the European Joint Aviation Requirements (JAR). These proposals were developed in cooperation with the Joint Aviation Authorities (JAA) of Europe and the U.S. and European aviation industry through the Aviation Rulemaking Advisory Committee (ARAC). These changes are intended to benefit the public interest by standardizing certain requirements, concepts, and procedures contained in the airworthiness standards without reducing and potentially enhancing the current level of safety.

DATES: Comments must be received on or before [insert date 90/120 days from date of publication].

ADDRESSES: Comments on this notice may be mailed in triplicate to: Federal Aviation Administration, Office of the Chief Counsel, Attention: Rules Docket (AGC-200),

Docket No. xxxxx, 800 Independence Avenue SW., Washington, DC 20591; or delivered in triplicate to: Room 915G, 800 Independence Avenue SW., Washington, DC 20591. Comments delivered must be marked Docket No. xxxxx. Comments may be examined in Room 915G weekdays, except Federal holidays, between 8:30 a.m. and 5:00 p.m. In addition, the FAA is maintaining an information docket of comments in the Transport Airplane Directorate (ANM-100), Federal Aviation Administration, Northwest Mountain Region, 1601 Lind Avenue SW., Renton, WA 98055-4056. Comments in the information docket may be examined weekdays, except Federal holidays, between 7:30 a.m. and 4:00 p.m.

FOR FURTHER INFORMATION CONTACT: Mahinder K. Wahi, Flight Test and Systems Branch, ANM-111, Transport Airplane Directorate, Aircraft Certification Service, FAA, 1601 Lind Avenue SW., Renton, WA 98055-4056; telephone (206) 227-2142; facsimile (206) 227-1320.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to participate in this proposed rulemaking by submitting such written data, views, or arguments as they may desire. Comments relating to any environmental, energy, or economic impact that might result from adopting the proposals contained in this notice are invited. Substantive comments should be accompanied by cost estimates. Commenters should identify the regulatory docket or notice number and submit comments in triplicate to the Rules Docket address above. All comments received on or before the closing date for comments will be considered by the Administrator before taking action on this proposed rulemaking. The proposals contained in this notice may be changed in light of comments received. All comments received will be available in the Rules Docket, both before and after the comment period closing date, for

examination by interested persons. A report summarizing each substantive public contact with FAA personnel concerning this rulemaking will be filed in the docket. Persons wishing the FAA to acknowledge receipt of their comments must submit with those comments a self-addressed, stamped postcard on which is stated: "Comments to Docket No. xxxxx." The postcard will be date stamped and returned to the commenter.

Availability of the NPRM

Any person may obtain a copy of this notice by submitting a request to the Federal Aviation Administration (FAA), Office of Public Affairs, Attention: Public Inquiry Center, APA-230, 800 Independence Avenue SW., Washington, DC 20591; or by calling (202) 267-3484. The notice number of this NPRM must be identified in all communications. Persons interested in being placed on a mailing list for future rulemaking documents should also request a copy of Advisory Circular No. 11-2A, Notice of Proposed Rulemaking Distribution System, which describes the application procedure.

Background

The airworthiness standards for transport category airplanes are contained in 14 CFR part 25. Manufacturers of transport category airplanes must show that each airplane they produce of a different type design complies with the relevant standards of part 25. These standards apply to airplanes manufactured within the U.S. for use by U.S.-registered operators and to airplanes manufactured in other countries and imported under a bilateral airworthiness agreement.

In Europe, the Joint Aviation Requirements (JAR-25) were developed by the Joint Aviation Authorities (JAA) to provide a common set of airworthiness standards for use within the European aviation community. The airworthiness standards for European type certification of transport category airplanes, JAR-25, are based on part 25 of the FAR.

Airplanes certificated to the JAR-25 standards, including airplanes manufactured in the U.S. for export to Europe, receive type certificates that are accepted by the aircraft certification authorities of 23 European countries.

Although part 25 and JAR-25 are very similar, they are not identical. Differences between the FAR and the JAR can result in substantial additional costs when airplanes are type certificated to both standards. These additional costs, however, frequently do not bring about an increase in safety. For example, part 25 and JAR-25 may use different means to accomplish the same safety intent. In this case, the manufacturer is usually burdened with meeting both requirements, although the level of safety is not increased correspondingly. Recognizing that a common set of standards would not only economically benefit the aviation industry, but would also maintain the necessary high level of safety, the FAA and JAA consider harmonization to be a high priority.

In 1988, the FAA, in cooperation with the JAA and other organizations representing the American and European aerospace industries, began a process to harmonize the airworthiness requirements of the United States and the airworthiness requirements of Europe, especially in the areas of Flight Test and Structures.

In 1992, the FAA harmonization effort was undertaken by the ARAC. A working group of industry and government hydraulic systems specialists of Europe and the United States was chartered by notice in the Federal Register (57 FR 58843, December 12, 1992). The working group was tasked to develop a draft notice of proposed rulemaking (NPRM) and any collateral documents, such as advisory circulars, concerning new or revised requirements for hydraulic systems, and the associated test conditions for hydraulic systems, installed in transport category airplanes (§ 25.1435). The JAA is to develop a similar proposal to amend JAR-25, as necessary, to achieve harmonization.

The rulemaking proposal contained in this notice was developed by the Hydraulic Systems Harmonization Working Group. It was presented to the FAA by the ARAC as a recommendation.

The Aviation Rulemaking Advisory Committee

The ARAC was formally established by the FAA on January 22, 1991 (56 FR 2190) to provide advice and recommendations concerning the full range of the FAA's safety-related rulemaking activity. This advice was sought to develop better rules in less overall time using fewer FAA resources than are currently needed. The committee provides the opportunity for the FAA to obtain firsthand information and insight from interested parties regarding proposed new rules or revisions of existing rules.

There are 64 member organizations on the committee, representing a wide range of interests within the aviation community. Meetings of the committee are open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act.

The ARAC establishes working groups to develop proposals to recommend to the FAA for resolving specific issues. Tasks assigned to working groups are published in the Federal Register. Although working group meetings are not generally open to the public, all interested parties are invited to participate as working group members. Working groups report directly to the ARAC, and the ARAC must concur with a working group proposal before that proposal can be presented to the FAA as an advisory committee recommendation.

The activities of the ARAC will not, however, circumvent the public rulemaking procedures. After an ARAC recommendation is received and found acceptable by the FAA, the agency proceeds with the normal public rulemaking procedures. Any ARAC participation in a rulemaking package will be fully disclosed in the public docket.

Discussion of the Proposals

The FAA proposes amending § 25.1435, Amendment 25-72, as recommended by the ARAC, to harmonize this section with JAR-25. The JAA intend to publish a Notice of Proposed Amendment (NPA), also developed by the Hydraulic Systems Harmonization Working Group, to revise JAR-25 as necessary to ensure harmonization in those areas for which the proposed amendments differ from the current JAR-25, Change 14. When it is published, the NPA will be placed in the docket for this rulemaking.

Generally, the FAA proposes to: (1) Add appropriate existing-JAR requirements to achieve harmonization; (2) Move some of the existing regulatory text to an advisory circular ; (3) Consolidate and/or separate requirement subparagraphs for clarity; and (4) Revise airplane static proof pressure test requirements to require a complete functional (dynamic) airplane test at a lower pressure.

A new proposed Advisory Circular (AC) 25.1435-1 has been developed to ensure consistent application of these proposed revised standards. Public comments concerning the AC 25.1435-1 are invited by separate notice published elsewhere in this issue of the Federal Register. The JAA intend to publish an Advisory Material Joint (AMJ), also developed by the Harmonization Working Group, to accompany their NPA. The proposed AC and the proposed AMJ contain harmonized advisory information.

The following is a discussion of the specific proposals prescribed in this NPRM.

Proposal 1. The FAA proposes to replace current § 25.1435(a)(1) to add the existing requirements of JAR 25.1435(a)(10) and associated Appendix K requirements regarding design load factors for proof and ultimate pressure conditions for elements of the hydraulic system (see proposal 2 below regarding current § 25.1435(a)(1)). The proof

and ultimate pressure conditions are defined as the design operating pressure times the factors of safety. This is done to address unusually high pressures which may be seen in service, material defects and differences, manufacturing/construction tolerances and the consequences of failures (e.g. pressure vessel failure). The proposed load factors, ranging between 1.5 and 4.0, relate to the design operating pressure (DOP) and apply to tubes, fittings, pressure vessels containing gas at high pressure (e.g., accumulators) and at low pressure (e.g. hydraulic reservoirs), hoses, and all other elements.

By adopting these JAR minimum factors of safety standards which currently are not specifically stated in the FAR, the FAA intends to maintain an existing level of safety because normal U.S. Industry practices meet or exceed these standards.

DOP is the normal maximum steady pressure. Excluded are reasonable tolerances and transient pressure effects such as may arise from acceptable pump ripple or reaction to system functioning or flow demands that may affect fatigue. In localized areas of systems and system elements the DOP may be different from the DOP for the system as a whole due to the range of normally anticipated airplane operational, dynamic and environmental conditions. Such differences must be taken into account. The term "design operating pressure" would be discussed in AC 25.1435-1.

Proposal 2. The FAA proposes to redesignate the current § 25.1435(a)(1) as § 25.1435(a)(2), delete the word "loads" from "pressure loads" ("loads" is redundant) and edit some text to avoid repetition. The terms "limit structural load", and a recommended minimum time to hold pressure would be discussed in AC 25.1435-1.

Proposal 3. The FAA proposes to redesignate the current § 25.1435(a)(2) as

a new § 25.1435(a)(3), delete the word "loads" from "pressure loads" ("loads" is redundant) and edit some text to avoid repetition. The terms "ultimate structural load" and a minimum time to hold pressure would be discussed in AC 25.1435-1.

Proposal 4. The FAA proposes to add a new § 25.1435(a)(4) that would contain the current requirements of § 25.1435(b)(2)(i) and (b)(2)(ii) regarding induced loads, pressure transients, and fatigue as well as the current JAR 25.1435(a)(11) requirements regarding fatigue design considerations accounting for fluctuating or repeated external or internal loads and pressure transients. These loads could be structurally or environmentally induced. By delineating these requirements, the FAA intends to ensure that each element is designed to provide fatigue resistance capability consistent with anticipated element usage, thus maintaining the current level of safety. The terms "fatigue", and "externally induced loads" would be discussed in AC 25.1435-1.

Proposal 5. The FAA proposes to add a new § 25.1435(a)(5) that would contain the current requirements of § 25.1435(b)(2)(i) through (b)(2)(v), except those addressed under proposal 4 above, as well as parts of the current JAR 25.1435 (a)(5) and (a)(6) requirements addressing excessive vibration, abrasion, corrosion, mechanical damage, and the ability to withstand inertia loads. These requirements would be consolidated and simplified by stating that each element must be designed to perform as intended under all environmental conditions for which the airplane is certificated. An acceptable means of compliance would be included in AC 25.1435-1.

Proposal 6. The FAA proposes to add a modified version of the existing JAR 25.1435(a)(2) as § 25.1435(b)(1), requiring means to indicate appropriate system

parameters at a flight crewmember station if (1) the system performs a function necessary for continued safe flight and landing, or (2) in the event of hydraulic system malfunction, corrective action by the crew is required to ensure continued safe flight and landing. The existing JAR25.1435(a)(2) requires fluid quantity and pressure indication under specified circumstances; prior to Amendment 25-72, § 25.1435 contained an identical requirement. It was considered at the time that this requirement is covered by § 25.1309(c), which requires that warning information must be provided to alert the crew to unsafe system operating conditions, and to enable them to take appropriate corrective action, and the § 25.1435 requirement was therefore deleted. It is, however, now recognized that there is value in defining indication requirements for hydraulic systems and implications of their loss. The existing level of safety would not be impacted since the FAA is proposing to adopt an existing industry practice. The term "appropriate system parameters" would be discussed in AC 25.1435-1. (Note: see proposal 12 below with respect to status of current § 25.1435(b)(1) requirements).

Proposal 7. The FAA proposes to replace the current § 25.1435(b)(2) by adding a modified version of the current JAR 25.1435(a)(4) and (a)(7) to require that each system have means to ensure that system pressures remain within the design capabilities of each element. Prior to Amendment 25-72, § 25.1435 contained a requirement that was identical to the current JAR requirement, but it was characterized as both containing arbitrary pressure transient limits and unnecessary because the intent is covered under § 25.1309. The requirement was therefore deleted from § 25.1435. The proposed version deletes the arbitrary limits but requires that the intent be specifically addressed by § 25.1435(b)(2) to ensure consideration of the pressure and volume related transients that are unique to the hydraulic systems. There would be no impact on level of safety since an

existing industry practice is being adopted. An acceptable means of compliance with § 25.1435(b)(2) would be included in AC 25.1435-1.

Proposal 8. The FAA proposes to add a new § 25.1435(b)(3) which contains a modified version of the existing JAR 25.1435(a)(5) requirements regarding the means to minimize harmful or hazardous concentrations of the hydraulic fluid or vapors, if liberated in any form, into the crew and passenger compartments during flight. Prior to Amendment 25-72, § 25.1435 contained an identical requirement. It was considered at the time that § 25.831(b) covers this requirement under a general statement that the ventilation air must be free of hazardous or harmful gases or vapors. However, § 25.831(b) specifies allowable limits for carbon monoxide and carbon dioxide, but no other products. It could be construed that those two gases are the only hazardous products. § 25.1435 is therefore revised to state the specific requirement with respect to the hydraulic fluid or vapors.

The JAR requirement currently states, in relevant part, that "there must be a means to prevent harmful or hazardous concentration of fluid . . ." In recognition of the fact that absolute prevention is not an achievable objective, the FAA proposes that the hydraulic system must have "means to minimize the release of harmful or hazardous concentrations . . ." To show compliance with this requirement, an applicant would have to show, both that the likelihood of releases has been minimized, and that, if there is such a release, the concentrations from the release would also be minimized. The level of safety remains unaffected because it's an existing industry practice to address this issue. An acceptable means of compliance with § 25.1435(b)(3) and a discussion of the terms "harmful" and "hazardous" would be included in AC 25.1435-1.

Proposal 9. The FAA proposes to redesignate the existing § 25.1435 (c) as § 25.1435(b)(4); this is identical to the existing JAR 25.1435(c) requirements regarding use of flammable hydraulic fluid and fire protection. A discussion of the term "flammable hydraulic fluid" would be included in AC 25.1435-1.

Proposal 10. The FAA proposes to add a new § 25.1435(b)(5), containing the current JAR 25.1435(d) requirements that the airplane manufacturer must specify the approved hydraulic fluid(s) suitable to be used in the system(s) and ensure that the system(s) meet the applicable placarding requirements of the current § 25.1541. Although it is a standard U.S. industry practice to identify the compatible hydraulic fluid on each component's name plate, the practice may not be universal. In order to minimize the potential use of incompatible fluids, seals, etc. in any system , it is necessary to include this requirement. A discussion of mixability of hydraulic fluids would be included in AC 25.1435-1.

Proposal 11. Current § 25.1435(b)(2) requirements for hydraulic system compliance by test and analysis would be separated into §§ 25.1435(c), (c)(1) and (c)(2); the list of environmental factors [current § 25.1435(b)(2)(ii) through (b)(2)(v)] would be moved to AC 25.1435-1; and, text in the aforementioned sections would be clarified. In addition, analysis may be used in place of or to supplement testing, where shown to be reliable and appropriate. A discussion on endurance and fatigue testing, and simulated failures would be included in AC 25.1435-1.

Proposal 12. Current § 25.1435(b)(1) requirements for static testing of a complete hydraulic system to1.5 times the design operating pressure (without deformation of any part of the system that would prevent performance of intended function) would be

replaced with a new § 25.1435(c)(3) requirement that "the complete hydraulic system must be functionally tested on the airplane over the range of motion of all associated user systems". "The test must be conducted at the system relief pressure or 1.25 times the DOP if a system pressure relief device is not part of the system design." This proposal reflects the recently granted petition for exemption to the Boeing Company, Regulatory Docket No. 27384. The petition, any comments received, and a copy of the final disposition are filed in the assigned regulatory docket and are available for examination in the Rules Docket (AGC 200), room 915G, FAA Headquarters Building (FOB 10A), 800 Independence Avenue SW., Washington, DC 20591; telephone (202) 267-3132. A discussion on relief pressure settings and an acceptable means of compliance with § 25.1435(c)(3) would be included in AC 25.1435-1.

The FAA considers that the proposed functional (i.e., dynamic) test more closely approximates actual operating conditions than the existing static test. This is because for the static test, several parts of the system and associated relief valves (including return lines) may need to be disabled to allow system pressurization at 1.5 times the design operating pressure because the relief valves are designed to open at a pressure lower than 1.5 times the design operating pressure. Although the proposed test pressure would be lower than 1.5 times the design operating pressure, all elements must still be able to withstand at least 1.5 times the design operating pressure per current § 25.1435(a)(2) (proposed § 25.1435(a)(3)), at least retaining and potentially enhancing the current level of safety by identification of additional dynamic interference problems.

Regulatory Evaluation Summary

Regulatory Evaluation, Regulatory Flexibility Determination, and Trade Impact Assessment

Changes to federal regulations must undergo several economic analyses. First, Executive Order 12866 directs Federal agencies to promulgate new regulations or modify existing regulations only if the potential benefits to society outweigh the potential costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Finally, the Office of Management and Budget directs agencies to assess the effect of regulatory changes on international trade. In conducting these assesments, the FAA has determined that this proposed rule: 1) would generate benefits exceeding its costs and is not "significant" as defined in Executive Order 12866; 2) is not "significant" as defined in DOT's Policies and Procedures; 3) would not have a significant impact on a substantial number of small entities; and 4) would lessen restraints on international trade. These analyses, available in the docket, are summarized below.

Costs and Benefits

Manufacturers of small transport category airplanes could experience additional costs totalling approximately $50,000 per type certification resulting from proposals 1 (design load factors) and 12 (systems clearance check). For manufacturers of large transport category airplanes, the cost differential could range from a $25,000 cost reduction (for one manufacturer, resulting from proposal 12) to a $100,000 - $200,000 cost increase (for another manufacturer, resulting from proposal 4).

The proposed changes would increase harmonization and commonality between American and European airworthiness standards, thereby eliminating unnecessary duplication of airworthiness requirements and reducing manufacturers' certification costs. One manufacturer of small transport category airplanes estimated such cost-savings could range between $30,000 and $90,000 per type certification (pertaining to hydraulic

systems only). Corresponding savings for large transport category airplane type certifications would be several times these amounts. The cost savings from harmonization would easily exceed the relatively low incremental costs of the rule. Potential safety enhancement resulting from specification of minimum accepted standards would supplement these benefits. Consequently, the FAA finds the proposed rule to be cost-beneficial.

Proposal 1. These changes codify existing industry standards. As such, they would not result in additional costs for most manufacturers. However, one manufacturer of small transport category airplanes estimated increased testing costs of approximately $25,000 per type certification. Codification of the proposed standards would ensure that current safety levels are retained.

Proposals 2, 3, and 9. There would be no additional costs associated with these minor changes.

Proposal 4. Although some of the changes described are new requirements in the FAR, most American manufacturers of large transport category airplanes are already in compliance with the similar current European standards, which had to be met in order to market airplanes in JAA member countries. The modified testing and analysis regime is already in place. Initial first-time costs have already been incurred; such costs have diminished in recent certifications. Consequently, actual incremental costs would be negligible. One manufacturer, however, indicated that additional testing and analysis costs, ranging between $100,000 and $200,000 per type certification, would be incurred for the first one or two type certifications. Learning curve efficiencies would likely reduce these costs thereafter. Manufacturers of small transport category airplanes, on the other hand, expect no or negligible additional costs attributable to the new fatigue-related

proposals. Codification of the proposed standards would ensure that minimum acceptable fatigue requirements are specified with potential for safety enhancement.

Proposals 5, 6, 7, 8, and 10. These changes codify existing industry standards and would not result in additional certification/production costs. Codification of the proposed standards would ensure that current safety levels are retained.

Proposal 11. There would be no additional costs associated with these revisions. The use of analysis in lieu of or supplemental to testing may reduce certification costs in some cases.

Proposal 12. Most manufacturers of transport category airplanes would not experience additional costs associated with dynamic testing of hydraulic systems. In fact, testing time and associated costs could be reduced to some small extent since, unlike static testing, the proposed dynamic testing would not entail disabling any system(s) or otherwise reconfiguring the airplane. One manufacturer of large transport category airplanes estimates potential savings of approximately $25,000 per type certification in this regard. However, a manufacturer of small transport category airplanes estimates $25,000 in additional testing, analysis, and report preparation costs per type certification attributable to this proposal. The proposed requirements would at least retain, and potentially enhance, the current level of safety by identification of additional dynamic interference problems.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily or disproportionately burdened by government regulations. The RFA requires a Regulatory Flexibility Analysis if a rule would have a significant economic impact, either detrimental or beneficial, on a substantial number of small entities. FAA Order 2100.14A, Regulatory Flexibility Criteria and Guidance, prescribes standards for complying with RFA review requirements in FAA rulemaking actions. The order defines "small entities" in terms of size thresholds, "significant economic impact" in terms of annualized cost threshold, and "sustantial number" as a number which is not less than eleven and which is more than one-third of the small entities subject to the proposed or final rule.

The proposed rule would affect manufacturers of transport category airplanes produced under future new airplane type certifications. For manufacturers, Order 2100.14A specifies a size threshold for classification as a small entity as 75 or fewer employees. Since no transport category airplane manufacturer has 75 or fewer employees, the proposed rule would not have a significant economic impact on a substantial number of small manufacturers.

International Trade Impact Assessment

The proposed rule would not constitute a barrier to international trade, including the export of American airplanes to foreign countries, and the import of foreign airplanes into the United States. Instead, the proposed changes to the FAR would harmonize with corresponding existing or proposed standards in the JAR, thereby lessening restraints on trade.

Federalism Implications

The amended regulations proposed in this rulemaking would not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, in accordance with Executive Order 12612, it is determined that this proposal would not have sufficient federalism implications to warrant preparing a Federalism Assessment.

Conclusion

Because the proposed changes to standardize specific hydraulic systems test requirements of part 25 are not expected to result in substantial economic cost, the FAA has determined that this proposed regulation would not be significant under Executive Order 12866. Because this is an issue which has not prompted a great deal of public concern, the FAA has determined that this action is not significant under DOT Regulatory Policies and Procedures (44 FR 11034, February 25, 1979). In addition since there are no small entities affected by this proposed rulemaking, the FAA certifies, under the criteria of the Regulatory Flexibility Act, that this rule, if adopted, will not have a significant economic impact, positive or negative, on a substantial number of small entities. An initial regulatory evaluation of the proposal, including a Regulatory Flexibility Determination and Trade Impact Analysis, has been placed in the docket. A copy may be obtained by contacting the person identified under **FOR FURTHER INFORMATION CONTACT.**

List of Subjects

14 CFR Part 25

Aircraft, Aviation safety, Federal Aviation Administration, Reporting and recordkeeping requirements

The Proposed Amendments

Accordingly, the Federal Aviation Administration (FAA) proposes to amend 14 CFR part 25 of the Federal Aviation Regulations (FAR) as follows:

PART 25 - AIRWORTHINESS STANDARDS - TRANSPORT CATEGORY AIRPLANES

1. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. app. 1344, 1354(a), 1355, 1421, 1423, 1424, 1425, 1428, 1429, 1430; 49 U.S.C. 106(g); and 49 CFR 1.47(a).

2. Section 25.1435 is revised to read as follows:

§ 25.1435 Hydraulic systems

(a) Element design. Each element of the hydraulic system must be designed to:

(1) Withstand the proof pressure without leakage or permanent deformation that prevents it from performing its intended function, and the ultimate pressure without rupture. The proof and ultimate pressures are defined in terms of the design operating pressure (DOP) as follows:

Element	Proof(xDOP)	Ultimate(xDOP)
1. Tubes & fittings.	1.5	3.0
2. Pressure vessels containing gas		
High pressure (e.g., accumulators)	3.0	4.0
Low pressure (e.g., reservoirs)	1.5	3.0
3. Hoses	2.0	4.0
4. All other elements	1.5	2.0

(2) Withstand, without deformation that would prevent it from performing its intended function, the design operating pressure in combination with limit structural loads that may be imposed;

(3) Withstand, without rupture, the design operating pressure multiplied by a factor of 1.5 in combination with ultimate structural load that can reasonably occur simultaneously;

(4) Withstand the fatigue effects of all cyclic pressures, including transients, and associated externally induced loads. The fatigue life of the element must take into account the consequences of element failure; and

(5) Perform as intended under all environmental conditions for which the airplane is certificated.

(b) System design. Each hydraulic system must:

(1) Have means to indicate appropriate system parameters located at a flight crew member station if

(i) It performs a function necessary for continued safe flight and landing; or

(ii) In the event of hydraulic system malfunction, corrective action by the crew to ensure continued safe flight and landing is necessary;

(2) Have means to ensure that system pressures, including transient pressures and pressures from fluid volumetric changes in elements that are likely to remain closed long enough for such changes to occur, are within the design capabilities of each element, such that they meet the requirements defined in § 25.1435(a)(1) through (a)(5);

(3) Have means to minimize the release of harmful or hazardous concentrations of hydraulic fluid or vapors into the crew and passenger compartments during flight;

(4) Meet the applicable requirements of §§ 25.863, 25.1183, 25.1185, and 25.1189 if a flammable hydraulic fluid is used; and

(5) Be designed to use any suitable hydraulic fluid specified by the airplane manufacturer, which must be identified by appropriate markings as required by § 25.1541.

(c) Tests

To demonstrate compliance with § 25.1435 and support compliance with § 25.1309, tests must be conducted on the hydraulic system(s), and/or subsystem(s) and elements, except that analysis may be used in place of or to supplement testing, where shown to be reliable and appropriate. All internal and external influences must be taken into account to an extent necessary to evaluate their effects, and to assure reliable system and element functioning and integration. Failure or unacceptable deficiency of an element or system must be corrected and be sufficiently retested, where necessary.

(1) The system(s), subsystem(s), or element(s) must be subjected to performance, fatigue, and endurance tests representative of airplane ground and flight operations.

(2) The complete system must be tested to determine proper functional performance and relation to the other systems, including simulation of relevant failure conditions, and to support or validate element design.

(3) The complete hydraulic system(s) must be functionally tested on the airplane in normal operation over the range of motion of all associated user systems. The test must be conducted at the system relief pressure or 1.25 times the DOP if a system pressure relief device is not part of the system design. Clearances between hydraulic system elements and other systems or structural elements must remain adequate and there must be no detrimental effects.

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HYDRAULIC SYSTEM CERTIFICATION TESTS, AND ANALYSIS

ANM-110

1. PURPOSE. This Advisory Circular (AC) provides guidance material for use as an acceptable means, but not the only means, of demonstrating compliance with the requirements of § 25.1435 and other sections of the Federal Aviation Regulations (FAR) that contain hydraulic system requirements. It is not mandatory and does not constitute a regulation.

2. RELATED DOCUMENTS. Section 25.1435 of the FAR, as amended through Amendment 25-xx, and other sections relating to hydraulic installations.

a. Related Federal Aviation Regulations. Sections which prescribe requirements for the design, substantiation and certification of hydraulic systems include:

§ 25.301	Loads
§ 25.303	Factor of safety.
§ 25.863	Flammable fluid fire protection.
§ 25.1183	Flammable fluid-carrying components.
§ 25.1185	Flammable fluids.
§ 25.1189	Shutoff means.
§ 25.1301	Function and installation.
§ 25.1309	Equipment, systems and installations.
§ 25.1322	Warning, caution and advisory lights.
§ 25.1541	Markings and Placards

Additional part 25 sections (and their associated advisory circulars where applicable) that prescribe requirements which can have a significant impact on the overall design and configuration of hydraulic systems are, but are not limited to:

§ 25.671	General: Control systems
§ 25.729	Retracting mechanism

§ 25.903	Engines
§ 25.943	Negative acceleration (JAR 25x1315)

b. Advisory Circulars (AC's).

AC 25.1309-1A	System Design and Analysis
AC 120-42	Extended Range Operation with Two Engine Airplanes
AC 20-128	Design Considerations for Minimizing Hazards Caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor and Fan Blade Failures

Advisory Circulars can be obtained from the U.S. Department of Transportation, M-443.2, Subsequent Distribution Unit, Washington, D.C. 20590.

c. Technical Standard Orders (TSO's).

TSO-C47	Pressure Instruments-Fuel, Oil, and Hydraulic
TSO-C75	Hydraulic Hose Assemblies

Technical Standard Orders can be obtained from the Federal Aviation Administration (FAA), Aircraft Certification Service, Aircraft Engineering Division, Technical Analysis Branch (AIR-120), 800 Independence Ave. S.W., Washington, DC, 20591.

d. Society of Automotive Engineers (SAE) Documents.

ARP 4752	Aerospace - Design and Installation of Commercial Transport Aircraft Hydraulic Systems
ISO 7137	Environmental Conditions and Test Procedures for Airborne Equipment (not an SAE document but is available from the SAE)

These documents can be obtained from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania, 15096.

e. Military Documents.

MIL-STD-810	Environmental Test Methods and Engineering Guidelines

These documents can be obtained from DODSSP, Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.

3. BACKGROUND. Effective February 1, 1965, part 25 was added to the FAR to replace Part 4b of the Civil Air Regulations (CAR). For hydraulic systems, CAR 4b.653, 4b.654 and 4b.655 respectively became §§ 25.1435(a), 1435(b) and 1435(c) of the FAR. Since then § 25.1435 has been revised under Amendment 25-13 (1967), Amendment 25-23 (1970), Amendment 25-41 (1977), Amendment 25-72 (1990), and Amendment 25-XX (1996), to make the regulations more comprehensive and to delete redundancies.

In Europe, the Joint Aviation Requirements (JAR) -25 were developed by the Joint Aviation Authorities (JAA) to provide a common set of airworthiness standards for use within the European aviation community. The airworthiness standards for European type certification of transport category airplanes, JAR-25, are based on part 25 of the FAR.

Although part 25 and JAR-25 are very similar, they are not identical. Differences between the FAR and the JAR can result in substantial additional costs when airplanes are type certificated to both standards. These additional costs, however, frequently do not bring about an increase in safety. For example, part 25 and JAR-25 may use different means to accomplish the same safety intent. In this case, the manufacturer is usually burdened with meeting both requirements, although the level of safety is not increased correspondingly. Recognizing that a common set of standards would not only economically benefit the aviation industry, but would also maintain the necessary high level of safety, the FAA and JAA consider harmonization to be a high priority.

In 1992, the harmonization effort was undertaken by the Aviation Rulemaking Advisory Committee (ARAC). A working group of industry and government hydraulic systems specialists of Europe and the United States was chartered by notice in the Federal Register (57 FR 58843, December 12, 1992). The working group was tasked to develop harmonized standards and any collateral documents, such as advisory circulars, concerning new or revised requirements for hydraulic systems, and the associated test conditions for hydraulic systems, installed in transport category airplanes (§ 25.1435).

The advisory material contained in this circular was developed by the Hydraulic Systems Harmonization Working Group to ensure consistent application of the revised standards.

4. DISCUSSION.

a. Element Design.

(1) (Ref. § 25.1435(a)(1)) The design operating pressure (DOP) is the normal maximum steady pressure. Excluded are reasonable tolerances, and transient pressure effects such as may

arise from acceptable pump ripple or reactions to system functioning or demands that may affect fatigue. Fatigue is addressed in paragraph (a)(4) of this section.

In local areas of systems and elements, the DOP may be different from the above due to the range of normally anticipated airplane operational, dynamic, and environmental conditions. Such differences must be taken into account.

For (a)(1), (a)(2), and (a)(3), the pressure and structural loads, as applicable, should be sustained for sufficient time to enable adequate determination that compliance is demonstrated. Typically a time of 2 minutes for proof conditions and 1 minute for ultimate condition will be considered acceptable.

The term 'pressure vessels' is not intended to include small volume elements such as lines, fittings, gauges, etc. It may be necessary to use special factors for elements fabricated from non-metallic/composite materials.

(2) (Ref. § 25.1435(a)(2)) Limit structural loads are defined in § 25.301(a). For hydraulic actuators equipped with hydraulic or mechanical locking features, such as flight control actuators and power steering actuators, the actuators and other loaded elements must be designed for the most severe combination of internal and external loads that may occur in use. The loads to be considered include, but are not limited to (a) air or ground maneuver loads, (b) dynamic transients, (c) gust conditions, and (d) the maximum hydraulic pressures that could occur simultaneously with the external loads from (a) through (c). For hydraulic actuators that are free to move with external loads, i.e., do not have locking features, the structural loads are the same as the loads produced by the hydraulic actuators.

(3) (Ref. § 25.1435(a)(3)) For compliance, the combined effects of the ultimate structural load(s) as defined in §§ 25.301 and 25.303 and the DOP, which can reasonably occur simultaneously, shall be taken into account with a factor of 1.5 applied to the DOP. In this case the overall structural integrity of the element should be maintained. However, it may be permissible for this element to suffer leakage, permanent deformation, operational/functional failure or any combination of these conditions.

(4) (Ref. § 25.1435(a)(4)) Fatigue, the repeated load cycles of an element, is a significant contributor to element failure. Hydraulic elements are mainly subjected to pressure loads, but may also see externally induced cyclical loads (e.g. structural, thermal, etc.). The applicant must define the load cycles for each element. The number of load cycles must be evaluated to produce equivalent fatigue damage encountered during the life of the aircraft or to support the assumptions used in § 25.1309 analysis. For example, if the failure analysis of the system allows that an element failure may occur at 25% of aircraft life, the element fatigue life should at least support this assumption.

(5) (Ref. 25.1435(a)(5)) Airplane environmental conditions that an element should be designed for are those under which proper function is required. They may include, but are not limited to: temperature, humidity, vibration, acceleration forces, icing, ambient pressure, electromagnetic effects, salt spray, cleaning agents, galvanic, sand, dust, and fungus. They may be location specific (e.g., in pressurized cabin vs. in unpressurized area) or general (attitude). For further guidance on environmental testing, suitable references include, but are not limited to: Military Standard, MIL-STD-810 "Environmental Test Methods and Engineering Guidelines", Radio Technical Commission for Aeronautics Document No. DO-160C (Environmental Conditions and Test Procedures for Airborne Equipment) as referenced in advisory circular No. AC 21-16C, and International Organization for Standardization Document No. ISO 7137-Environmental Conditions and Test Procedures for Airborne Equipment.

b. System Design. (Ref. 25.1435(b)) These requirements are unique to hydraulic systems, and may complement § 25.1309. Other design features for hydraulic systems that may be advantageous in demonstrating compliance by eliminating undesirable conditions or effects are: (a) Design and install hydraulic pumps such that loss of fluid to or from the pump cannot lead to events that create a hazard that might prevent continued safe operation. For example, engine driven pump shaft seal failure or leakage, in combination with a blocked fluid drain, resulting in engine gear box contamination with hydraulic fluid and subsequent engine failure. (b) Design the system to avoid hazards arising from the effects of abnormally high temperatures which may occur in the system under fault conditions.

(1) (Ref. 25.1435(b)(1)) Appropriate system parameters may include, but are not limited to, pump or system temperatures and pressures, system fluid quantities, and any other parameters which give the pilot indication of the functional level of the hydraulic systems.

(2) (Ref. 25.1435(b)(2)) Compliance may be shown by designing the systems and elements to sustain the transients without damage or failure, or by providing dampers, pressure relief devices, etc.

(3) (Ref. 25.1435(b)(3)) Harmful or hazardous fluid or vapor concentrations are those that can cause short term incapacitation of the flight crew or long term health effects to the passengers or crew. Compliance may be shown by taking design precautions, to minimize the likelihood of releases and, in the event of a release to minimize the concentrations. Suitable precautions, based on good engineering judgment, include separation of air conditioning and hydraulic systems, shut off capability to hydraulic lines, reducing the number of joints and elements, shrouding etc.. In case of leakage, sufficient drainage should be provided.

(4) (Ref. 25.1435(b)(4)) Unless it has been demonstrated that there are no circumstances which can exist (on the airplane) under which the hydraulic fluid can be ignited in any of its physical forms (liquid, atomized, etc.), the hydraulic fluid should be considered to be flammable.

(5) (Ref. 25.1435(b)(5)) If more than one approved fluid is specified, the term suitable hydraulic fluid is intended to include acceptable mixtures.

c. Tests. (Ref. 25.1435(c)) Test conditions should be representative of the environment that the element, subsystem or system may be exposed to in the design flight envelope. This may include loads, temperatures, altitude effects, humidity, and other influences (electrical, pneumatic, etc.). Testing may be conducted in simulators, stand alone rigs, integrated laboratory rigs, or on the airplane. The test plan should describe the objectives and test methods. All interfaces between the airplane elements and the test facilities should be adequately represented.

(1) (Ref. 25.1435(c)(1)) Testing for performance should demonstrate rates and responses required for proper system operation. Testing for fatigue (the repeated load cycling of an element) and endurance (the ability of parts moving relative to each other to continue to perform their intended function) should be sufficient to show the assumptions used in § 25.1309 analysis are correct, but are not necessary to demonstrate airplane design life. As part of demonstrating that the element(s), sub-system(s), or system(s) perform their intended functions, the manufacturer may select procedures and factors of safety identified in accepted manufacturing, national, military, or industry standards provided that it can be established that they are suitable for the intended application. Minimum design factors specified in those standards or the regulations may be used unless more conservative factors have been agreed to with the Administrator.

An acceptable test approach for fatigue or endurance is to:

(a) Define the intended element life
(b) Determine the anticipated element duty cycle
(c) Conduct testing using the anticipated or an equivalent duty cycle

(2) (Ref. 25.1435(c)(2)) The tests should include simulation of hydraulic system failure conditions in order to investigate the effect of those failures and to correlate with the failure conditions considered for compliance with § 25.1309. Relevant failure conditions to be tested are those which cannot be shown to be extremely improbable and have effects assessed to be major, hazardous, or have significant system interaction or operational implications.

(3) (Ref. 25.1435(c)(3)) Compliance with § 25.1435(c)(3) can be accomplished by applying a test pressure to the system using airplane pumps or an alternate pressure source (e.g., a ground cart). The test pressure to be used should be just below the pressure required to initiate system pressue relief (cracking pressure). Return and suction pressures are allowed to be those which result from application of the test pressure to the pressure side of the system.

Some parts of the system(s) may need to be separately pressurized to ensure the system is completely tested. Similarly, it may be permissible that certain parts of the system need not be tested if it can be shown that they do not constitute a significant part of the system with respect to the evaluation of adequate clearances or detrimental effects.

U.S. Department
of Transportation

**FEDERAL AVIATION
ADMINISTRATION**

Washington, D.C. 20591

PRELIMINARY REGULATORY EVALUATION, INITIAL REGULATORY FLEXIBILITY DETERMINATION, AND TRADE IMPACT ASSESSMENT

FOR

NOTICE OF PROPOSED RULEMAKING:

REVISION OF HYDRAULIC SYSTEMS AIRWORTHINESS STANDARDS TO HARMONIZE WITH EUROPEAN AIRWORTHINESS STANDARDS FOR TRANSPORT CATEGORY AIRPLANES

OFFICE OF AVIATION POLICY, PLANS, AND MANAGEMENT ANALYSIS
AIRCRAFT REGULATORY ANALYSIS BRANCH, APO-320
Arnold J. Hoffman
February 1995

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Executive Summary

This Regulatory Evaluation examines the impacts of a proposal to amend the airworthiness standards for hydraulic systems of transport category airplanes. The proposed changes to section 25.1435 of the Federal Aviation Regulations (FAR) would harmonize hydraulic systems design and test requirements with standards proposed for the European Joint Aviation Requirements (JAR). The proposals were developed in cooperation with the European Joint Aviation Authorities and the U.S. and European aviation industries through the Aviation Rulemaking Advisory Committee. The proposed changes would: (1) add appropriate existing JAR standards to achieve harmonization; (2) move some of the existing regulatory text to an advisory circular; (3) consolidate or separate some subparagraphs for clarity; and (4) revise airplane static proof pressure test requirements to require a complete functional (dynamic) airplane test at a lower pressure.

Although several revisions would be made to FAR § 25.1435, only three of them would impose additional costs. Most of the changes codify current industry practice or conform FAR § 25.1435 to corresponding sections of the JAR without substantive effects. Manufacturers of part 25 small airplanes could experience additional costs of approximately $50,000 per type certification. On the other hand, manufacturers of part 25 large airplanes could experience a cost differential ranging from a $25,000 cost reduction to a $200,000 cost increase. Cost savings from harmonization and potential safety enhancement would exceed any incremental cost increases.

The proposed rule would not have a significant economic impact on small entities. In addition, it would not constitute a barrier to international trade, including the export of American airplanes to foreign countries and the import of foreign airplanes into the United States. Instead, the proposed changes, by harmonizing with standards in the JAR, would lessen restraints on trade.

Regulatory Evaluation of NPRM: Revision of Hydraulic Systems Airworthiness Standards to Harmonize with European Airworthiness Standards for Transport Category Airplanes

I. Introduction

This Regulatory Evaluation examines the impacts of a proposal to amend the airworthiness standards for hydraulic systems of transport category airplanes. The proposed changes to section 25.1435 of the Federal Aviation Regulations (FAR) would harmonize hydraulic systems design and test requirements with standards proposed for the European Joint Aviation Requirements (JAR). The proposals were developed in cooperation with the European Joint Aviation Authorities (JAA) and the U.S. and European aviation industries through the Aviation Rulemaking Advisory Committee (ARAC). These changes would benefit the public interest by standardizing certain requirements, concepts, and procedures contained in the airworthiness standards without reducing, and potentially enhancing, the current level of safety.

The FAA proposes to: (1) add appropriate existing JAR standards to achieve harmonization; (2) move some of the existing regulatory text to an advisory circular (AC 25.1435-1); (3) consolidate or separate some subparagraphs for clarity; and (4) revise airplane static proof pressure test requirements, § 25.1435(b)(1), to require a complete functional (dynamic) airplane test at a lower pressure.

II. Background

The airworthiness standards for transport category airplanes are contained in part 25 of the FAR. These standards apply to airplanes manufactured within the U.S. and to airplanes manufactured in other countries and imported under a bilateral airworthiness agreement.

The JAA developed a common set of airworthiness standards for use within the European aviation community. The standards for European type certification of transport category airplanes, JAR-25, are based to a large extent on part 25 of the FAR. Type certificates issued under JAR-25 standards are accepted by the aircraft certification authorities of 23 European countries.

FAR part 25 and JAR-25 are, however, not identical. Certain differences between the standards can result in substantial additional certification costs when airplanes are type-certificated to both sets of standards. These additional costs do not necessarily bring about an increase in safety since the FAR may use different means than the JAR to accomplish the same safety intent.

Recognizing that a common set of standards would not only economically benefit the aviation industry but also maintain the necessary high level of safety, the FAA and JAA, in 1988, began a process to harmonize the airworthiness requirements of the U.S. and Europe. During the June 1992 FAA/JAA annual meeting in Toronto, Canada, the Aviation Rulemaking Advisory Committee (ARAC) was recognized as the forum through which rulemaking harmonization will be

achieved. The ARAC was formally established by the FAA on January 22, 1991 to provide advice and recommendations concerning the FAA's rulemaking program. The Hydraulic Systems Harmonization Working Group was formed and tasked to develop a draft Notice of Proposed Rulemaking (NPRM) and collateral documents relating to hydraulic systems of transport category airplanes. The JAA is developing similar proposals to amend JAR-25.

III. Proposed Changes and Associated Costs and Benefits

Although several revisions would be made to FAR § 25.1435, only three of them would impose additional costs (see below -- proposals 1,4, and 12, with the latter having potential cost savings for some manufacturers). Most of the changes codify current industry practice or conform FAR § 25.1435 to corresponding sections of the JAR. Adoption of the proposed changes would increase harmonization and commonality between American and European airworthiness standards. Harmonization would eliminate unnecessary duplication of airworthiness requirements, thus reducing manufacturers' certification costs. One manufacturer of part 25 small airplanes estimated such cost-savings could range between $30,000 and $90,000 per type certification (pertaining to hydraulic systems only). Equivalent savings for part 25 large airplane type certifications would probably be several times these amounts. Potential safety enhancement resulting from specification of minimum accepted standards would supplement these benefits.

Proposal 1. Current § 25.1435(a)(1) would be replaced by the existing JAR 25.1435(a)(10) and associated Appendix K requirements regarding design

load factors for proof and ultimate pressure conditions for elements of the hydraulic system (see proposal 2 below with respect to contents of current § 25.1435 (a)(1)). The proposed load factors, ranging between 1.5 and 4.0, relate to the design operating pressure (DOP) and apply to tubes, fittings, elements containing gas connected to a pneumatic pressure source (e.g. hydraulic reservoirs), elements containing pressurized gas connected to hydraulic pressure source (e.g. accumulators), hoses, and other miscellaneous elements. By adopting the JAR minimum factors of safety standards which currently are not specifically stated in the FAR, the FAA intends to retain an existing level of safety because normal U.S. industry practices meet or exceed these standards. DOP is the normal maximum steady pressure. Excluded are reasonable tolerances and transient pressure effects. In localized-areas of systems and system elements, the DOP may be different from the DOP for the system as a whole due to the range of normally anticipated airplane operational, dynamic and environmental conditions. Such differences must be taken into account. The term "design operating pressure" would be discussed in AC 25.1435-1.

The proposed changes would not result in additional certification/production costs for most manufacturers. However, one manufacturer of part 25 small airplanes estimated increased testing costs of approximately $25,000 per type certification. Codification of the proposed standards would ensure that current safety levels are retained.

Proposal 2. Current § 25.1435(a)(1) would be redesignated as § 25.1435(a)(2) with deletion of some extraneous words and other minor edits. The term "limit structural load" and a recommended minimum time to hold pressure would be discussed in AC 25.1435-1. There would be no additional costs associated with these minor changes.

Proposal 3. Current § 25.1435(a)(2) would be redesignated as new § 25.1435(a)(3) with deletion of some extraneous words and other minor edits. The term "ultimate structural load" and a minimum time to hold pressure would be discussed in AC 25.1435-1. There would be no additional costs associated with these minor changes.

Proposal 4. A new § 25.1435(a)(4) would be added, containing current § 25.1435(b)(2)(i) and (b)(2)(ii) requirements regarding induced loads, pressure transients, and fatigue, as well as the current JAR 25.1435(a)(11) requirements regarding fatigue design considerations accounting for fluctuating or repeated external or internal loads and pressure transients. These loads could be structurally or environmentally induced. By delineating these requirements, the FAA intends to ensure that each element is designed to provide fatigue resistance capability consistent with anticipated element usage, thus maintaining the current level of safety. The terms "fatigue," and "externally induced loads" would be discussed in AC 25.1435-1.

Although some of the changes described are new requirements in the FAR, most American manufacturers of large transport category airplanes are already in compliance with the similar current European standards, which had to be met in

order to market airplanes in JAA member countries. The modified testing and analysis regime is already in place. Initial "first time" costs have already been incurred and have diminished in recent certifications. Consequently, incremental costs incurred subsequent to harmonization would be negligible. One manufacturer, however, indicated that additional testing and analysis costs, ranging between $100,000 and $200,000 per type certification, would be incurred for the first one or two type certifications; learning curve efficiencies would likely reduce these costs thereafter. Manufacturers of part 25 small airplanes, on the other hand, expect no or negligible additional costs attributable to the new fatigue-related proposals.

Codification of the proposed standards would ensure that minimum acceptable fatigue requirements are specified with potential for safety enhancement.

Proposal 5. A new § 25.1435(a)(5) would be added, containing the current requirements of § 25.1435(b)(2)(i) through (b)(2)(v), except those addressed under proposal 4 above, as well as parts of the current JAR 25.1435(a)(5) and (a)(6) requirements to prevent excessive vibration, abrasion, corrosion, and mechanical damage, and to ensure the ability to withstand inertia loads. These requirements would be consolidated and simplified by stating that each element must be designed to perform as intended under all environmental conditions for which the airplane is certificated. An acceptable means of compliance would be included in AC 25.1435-1.

These changes codify existing industry standards for protection from physical/ environmental degradation and resistance to inertia loads and would not result in additional certification/production costs. Codification of the proposed standards would ensure that current safety levels are retained.

Proposal 6. A modified version of current JAR 25.1435 (a)(2) would be added to the FAR as a revised § 25.1435 (b)(1), requiring means to indicate the appropriate system parameters at a flight crewmember station if (1) the system performs a function necessary for continued safe flight and landing, or (2) in the event of hydraulic system malfunction, corrective action by the crew is required to ensure continued safe flight and landing (see proposal 12 below with respect to status of current § 25.1435(b)(1) requirements). The existing JAR 25.1435(a)(2) requires fluid quantity and pressure indication under specified circumstances; prior to Amendment 25-72 in 1990, FAR § 25.1435 contained an identical requirement. It was considered at the time that this requirement is covered by FAR § 25.1309(c), which requires that warning information must be provided to alert the crew to unsafe system operating conditions and to enable it to take appropriate corrective action, and the § 25.1435 requirement was therefore deleted. It is now recognized, however, that there is value in defining indication requirements for hydraulic systems and implications of their loss. The term "appropriate system parameters" would be discussed in AC 25.1435-1.

These changes codify existing industry standards and would not result in additional certification/production costs. Codification of the proposed standards would ensure that current safety levels are retained.

Proposal 7. The current § 25.1435(b)(2) would be replaced by a modified version of the current JAR 25.1435(a)(4) and (a)(7) to require that each system have means to ensure that system pressures remain within the design capabilities of elements (see proposal 11 below with respect to contents of current § 25.1435(b)(2)). Prior to Amendment 25-72, § 25.1435 contained the identical JAR requirement, but it was characterized as containing arbitrary transient limits and being unnecessary because the intent is covered under § 25.1309 (Equipment, systems, and installations). The requirement was therefore deleted from § 25.1435. The proposed version deletes the arbitrary limits but requires that the intent be specifically addressed by § 25.1435(b)(2) to ensure consideration of the pressure and volume related transients that are unique to the hydraulic systems. An acceptable means of compliance with § 25.1435(b)(2) would be included in AC 25.1435-1.

There would be no additional costs associated with these changes since industry is currently meeting the same requirements under § 25.1309. Clarification of standards for pressure/volume transients under § 25.1435 would ensure that current safety levels are retained.

Proposal 8. A new § 25.1435(b)(3) would be added with new requirements for minimizing harmful or hazardous concentrations of hydraulic fluid or vapors, if liberated in any form, into the crew or passenger compartments during flight. These proposed standards would be similar to those in existing JAR 25.1435(a)(5). Prior to amendment 25-72, § 25.1435 contained an identical requirement. The amendment removed the requirements since it was assumed that similar air standards were imposed by § 25.831(b) in the general statement

that the ventilation air must be free of hazardous or harmful gases or vapors. However, § 25.831(b) specifies allowable limits for carbon monoxide and carbon dioxide, but no other products. It could be construed that those two gases are the only hazardous products. Section 25.1435 is therefore proposed to be revised to state the requirement with respect to hydraulic fluid or vapors generally. An acceptable means of compliance with § 25.1435(b)(3) and a discussion of the terms "harmful" and "hazardous" would be included in AC 25.1435-1.

Since the proposed changes codify existing industry standards, there would be no additional certification/production costs. Codification of the proposed standards would ensure that current safety levels are retained.

Proposal 9. Current § 25.1435(c) would be redesignated as new § 25.1435(b)(4), which is identical to existing JAR 25.1435(c) requirements regarding use of flammable hydraulic fluid and fire protection. A discussion of the term "flammable hydraulic fluid" would be included in AC 25.1435-1. There would be no additional costs associated with this redesignation.

Proposal 10. A new § 25.1435(b)(5) would be added that would require manufacturers to specify the approved hydraulic fluid(s) suitable to be used in the system(s) and ensure that the system(s) meet the applicable placarding requirements of current § 25.1541. These requirements are the same as those in existing JAR 25.1435(d). Although it is standard industry practice to identify the compatible hydraulic fluid on each component's nameplate, the practice may not be universal. In order to minimize the potential use of

incompatible fluids, seals, etc. in any system, it is necessary to include these requirements. A discussion of mixability of hydraulic fluids from different suppliers would be included in AC 25.1435-1.

Since these changes codify existing industry standards, there would be no additional certification/production costs. Codification of the proposed standards would ensure that current safety levels are retained.

Proposal 11. Current § 25.1435(b)(2) requirements for hydraulic system compliance by test and analysis would be separated into §§ 25.1435(c), (c)(1) and (c)(2); the list of environmental factors (current § 25.1435(b)(2)(ii) through (b)(2)(v)) would be moved to AC 25.1435 and the text in these sections would be clarified. In addition, analysis may be used in place of or to supplement testing, where shown to be reliable and appropriate. A discussion on the number of endurance and fatigue cycles, guidance on conducting fatigue testing, and simulated failures would be included in AC 25.1435-1.

There would be no additional costs associated with these revisions. The use of analysis in place of or supplemental to testing may reduce certification costs in some cases.

Proposal 12. Current § 25.1435(b)(1) requirements for static testing of a complete hydraulic system to 1.5 times the design operating pressure (without deformation that would prevent performance of intended function) would be replaced with a new § 25.1435(c)(3) requirement that "the complete hydraulic system must be functionally tested on the airplane over the range of

motion of all associated user systems." "The test must be conducted at the system relief pressure or 1.25 times the DOP if a system pressure relief device is not part of the system design." This proposal reflects the recently granted petition for exemption to the Boeing Company, FAA Regulatory Docket No. 27384. A discussion on relief pressure settings and an acceptable means of compliance with § 25.1435(c)(3) would be included in AC 25.1435-1.

The FAA considers that the proposed functional (i.e., dynamic) test more closely approximates actual operating conditions than the existing static test. For the static test, several parts of the system and associated relief valves (including return lines) may require disabling to allow system pressurization at 1.5 times the design operating pressure because the relief valves are designed to open at pressures lower than 1.5 times the design operating pressure. Although the proposed test pressure would be lower than 1.5 times the design operating pressure, all elements must still be able to withstand at least 1.5 times the design operating pressure per current § 25.1435(a)(2) (proposed § 25.1435(a)(3)).

Most manufacturers of part 25 airplanes would not experience any increased costs associated with dynamic testing of hydraulic systems. In fact, since unlike static testing, the proposed dynamic testing does not entail disabling any system(s) or otherwise reconfiguring the airplane, testing time and associated costs could be reduced to some small extent. One manufacturer of part 25 large airplanes estimates potential savings of approximately $25,000 per type certification in this regard. However, a manufacturer of part 25

small airplanes estimates $25,000 in additional testing, analysis, and report preparation costs per type certification attributable to this proposal.

The proposed requirements at least retain, and potentially enhance, the current level of safety by identification of additional dynamic interference problems.

IV. Summary of Costs and Benefits

Manufacturers of part 25 small airplanes could experience additional costs totalling approximately $50,000 per type certification resulting from proposals 1 (design load factors) and 12 (system clearance check). For manufacturers of part 25 large airplanes, the cost differential could range from a $25,000 cost reduction (for one manufacturer, resulting from proposal 12) to a $100,000 - $200,000 cost increase (for another manufacturer, resulting from proposal 4). The cost savings from harmonization would easily exceed these relatively low additional costs. Potential safety enhancement resulting from specification of minimum accepted standards would supplement these benefits. Consequently, the FAA finds the proposed rule to be cost-beneficial.

V. Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by government regulations. The RFA requires a Regulatory Flexibility Analysis if

a proposed or final rule would have a significant economic impact, either detrimental or beneficial, on a substantial number of small entities. FAA Order 2100.14A, Regulatory Flexibility Criteria and Guidance, prescribes standards for complying with RFA review requirements in FAA rulemaking actions. The Order defines "small entities" in terms of size thresholds, "significant economic impact" in terms of annualized cost threshold, and "substantial number" as a number which is not less than eleven and which is more than one-third of the small entities subject to the proposed or final rule.

The proposed rule would affect manufacturers of transport category airplanes produced under future new airplane type certifications. For manufacturers, Order 2100.14A specifies a size threshold for classification as a small entity as 75 or fewer employees. Since no part 25 airplane manufacturer has 75 or fewer employees, the proposed rule would not have a significant economic impact on a substantial number of small manufacturers.

VI. International Trade Impact Assessment

The proposed rule would not constitute a barrier to international trade, including the export of American airplanes to foreign countries and the import of foreign airplanes into the United States. Instead, the proposed changes would harmonize with corresponding existing or proposed standards in the JAR, thereby lessening restraints on trade.

For Insertion Into Preamble of NPRM:

"Revision of Hydraulic Systems Airworthiness Standards to Harmonize with European Airworthiness Standards for Transport Category Airplanes"

Regulatory Evaluation, Regulatory Flexibility Determination, and Trade Impact Assessment

Changes to federal regulations must undergo several economic analyses. First, Executive Order 12866 directs Federal agencies to promulgate new regulations or modify existing regulations only if the potential benefits to society outweigh the potential costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Finally, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. In conducting these assessments, the FAA has determined that this proposed rule: 1) would generate benefits exceeding its costs and is not "significant" as defined in Executive Order 12866; 2) is not "significant" as defined in DOT's Policies and Procedures; 3) would not have a significant impact on a substantial number of small entities; and 4) would lessen restraints on international trade. These analyses, available in the docket, are summarized below.

Regulatory Evaluation Summary

Costs and Benefits

Manufacturers of part 25 small airplanes could experience additional costs totalling approximately $50,000 per type certification resulting from proposals 1 (design load factors) and 12 (system clearance check). For manufacturers of part 25 large airplanes, the cost differential could range from a $25,000 cost reduction (for one manufacturer, resulting from proposal 12) to a $100,000 - $200,000 cost increase (for another manufacturer, resulting from proposal 4).

The proposed changes would increase harmonization and commonality between American and European airworthiness standards, thereby eliminating unnecessary duplication of airworthiness requirements and reducing manufacturers' certification costs. One manufacturer of part 25 small airplanes estimated such cost-savings could range between $30,000 and $90,000 per type certification (pertaining to hydraulic systems only). Corresponding savings for part 25 large airplane type certifications would be several times these amounts. The cost savings from harmonization would easily exceed the relatively low incremental costs of the rule. Potential safety enhancement resulting from specification of minimum accepted standards would supplement these benefits. Consequently, the FAA finds the proposed rule to be cost-beneficial.

Proposal 1. These changes codify existing industry standards. As such, they would not result in additional costs for most manufacturers. However, one manufacturer of part 25 small airplanes estimated increased testing costs of approximately $25,000 per type certification. Codification of the proposed standards would ensure that current safety levels are retained.

Proposals 2, 3, and 9. There would be no additional costs associated with these minor changes.

Proposal 4. Although some of the changes described are new requirements in the FAR, most American manufacturers of large transport category airplanes are already in compliance with the similar current European standards, which had to be met in order to market airplanes in JAA member countries. The modified testing and analysis regime is already in place. Initial first-time costs have already been incurred; such costs have diminished in recent certifications. Consequently, actual incremental costs would be negligible. One manufacturer, however, indicated that additional testing and analysis costs, ranging between $100,000 and $200,000 per type certification, would be incurred for the first one or two type certifications. Learning curve efficiencies would likely reduce these costs thereafter. Manufacturers of part 25 small airplanes, on the other hand, expect no or negligible additional costs attributable to the new fatigue-related proposals. Codification of the proposed standards would ensure that minimum acceptable fatigue requirements are specified with potential for safety enhancement.

Proposals 5, 6, 7, 8, and 10. These changes codify existing industry standards and would not result in additional certification/production costs. Codification of the proposed standards would ensure that current safety levels are retained.

Proposal 11. There would be no additional costs associated with these revisions. The use of analysis in lieu of or supplemental to testing may reduce certification costs in some cases.

Proposal 12. Most manufacturers of part 25 airplanes would not experience additional costs associated with dynamic testing of hydraulic systems. In fact, testing time and associated costs could be reduced to some small extent since, unlike static testing, the proposed dynamic testing would not entail disabling any system(s) or otherwise reconfiguring the airplane. One manufacturer of part 25 large airplanes estimates potential savings of approximately $25,000 per type certification in this regard. However, a manufacturer of part 25 small airplanes estimates $25,000 in additional testing, analysis, and report preparation costs per type certification attributable to this proposal. The proposed requirements would at least retain, and potentially enhance, the current level of safety by identification of additional dynamic interference problems.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by

government regulations. The RFA requires a Regulatory Flexibility Analysis if a proposed or final rule would have a significant economic impact, either detrimental or beneficial, on a substantial number of small entities. FAA Order 2100.14A, Regulatory Flexibility Criteria and Guidance, prescribes standards for complying with RFA review requirements in FAA rulemaking actions. The Order defines "small entities" in terms of size thresholds, "significant economic impact" in terms of annualized cost threshold, and "substantial number" as a number which is not less than eleven and which is more than one-third of the small entities subject to the proposed or final rule.

The proposed rule would affect manufacturers of transport category airplanes produced under future new airplane type certifications. For manufacturers, Order 2100.14A specifies a size threshold for classification as a small entity as 75 or fewer employees. Since no part 25 airplane manufacturer has 75 or fewer employees, the proposed rule would not have a significant economic impact on a substantial number of small manufacturers.

International Trade Impact Assessment

The proposed rule would not constitute a barrier to international trade, including the export of American airplanes to foreign countries and the import of foreign airplanes into the United States. Instead, the proposed changes to the FAR would harmonize with corresponding existing or proposed standards in the JAR, thereby lessening restraints on trade.